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No. 442

"GLOSTER" HIGH LIFT BIPLANE WINGS

By H. E. Preston

From "The Gloster," January-February, 1927

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"GLOSTER" HIGH LIFT BIPLANE WINGS.*

By H. E. Preston.

It is thought that a general description of the "Gloster" Patent High-Lift Biplane Wings may be of general interest and particularly to those who have been engaged in the drawing and construction of such wings for the "Grebe" and "Gamecock."

The main object of these wings was to obtain a high lift without increasing the total drag, and the idea was conceived that, by using a deep high-lift section for the top wing and a medium section for the bottom wing, the mutual interference between the two would be such as to give greater efficiency of the combination as compared with two wings of equal section. To make this point clear, it should perhaps be explained that the lift of the lower wing of a biplane is reduced by the interference of the upper wing, while at the same time the lift of the top wing may tend to be slightly increased. This mutual interference effect varies with the position of the one wing in relation to the other. That is to say, a larger gap gives less interference, but of course a larger gap is objectionable because of the additional lengths of struts and wires entailed and also because, in many airplanes, the top wing is required as low as possible to give the best view for the pilot.

*From "The Gloster," House Journal of The Gloster Aircraft Co., Ltd., Volume 2, No. 5, January-February, 1927.

It is preferable therefore, in comparing the merits of the Gloster high-lift biplane to do so on a given basis. Taking the "Grebe" as an example, we have on the "Grebe" 254 sq.ft. of surface, consisting of about 140 sq.ft. of deep high-lift top wing plus 114 sq.ft. of medium lift bottom wing. This airplane has a total weight of 2,600 pounds and its landing speed is below 50 M.P.H. If a lower lift section were used for the top wing the wing area would require to be increased to at least 310 sq.ft. to give the same landing speed, and this increased area would require more struts and wires to brace the wings owing to the reduced spar depth and increased size of wing. On the other hand, if a deep section high-lift wing were used for the bottom wing, it would be necessary to increase the gap between the wings to avoid the loss in lift which would result from the relatively small gap used on the Gloster high-lift combination. So that, as regards maximum lift, the Gloster combination is more efficient for given conditions. It is not, however, only in lift that the arrangement is proved to be superior; there are, in fact, at least three further advantages obtained which I will describe in turn. First, the efficiency of the wings as regards drag. This feature is more technically involved, but may be briefly explained as follows: It is known that the top wing is arranged with a slightly greater angle of attack than the lower wing and although this setting contributes a good deal towards maximum lift obtained, it also assists in the drag being relatively low.

In effect what takes place is that at low speeds, when high lift is required, both wings contribute almost equally to support the airplane as a very efficient biplane. At higher speeds, the fact of having the lower wing at a smaller angle and also of a lower lift section, the majority of the weight of the airplane is supported on the top wing. This means that the combination approaches the monoplane at high speed to the extent that the top wing is taking most of the lift and, by so doing, receives a higher loading per square foot, which permits the section to operate in the region of its most efficient ratio of lift to drag. At the same time the lower wing is operated in the region of its own minimum drag.

This transference of lift just described from lower to top wing with change of speed brings in its train the next advantage obtained by the Gloster high-lift biplane.

This next advantage is an improvement in the stability of the airplane when the wings are arranged with a forward stagger. To make this point clear it will be understood that, for an airplane to be in balance, the center of the lift on the wings must be near to the center of gravity of the complete airplane and any variation of the center of lift (or center of pressure as it is called) will have to be balanced by a suitable balancing load on the stabilizer. For the purpose of checking out this balance the two wings are merged into one in a diagram giving what is in effect the equivalent single wing, the posi-

tion of which and the center of pressure on it are equivalent to the lift and center of pressure of the two separate wings. This is shown for an ordinary biplane in Figure 1. Here the equivalent wing remains approximately halfway between the two actual wings for all speeds and the center of pressure on the equivalent wing moves the same distance as the center of pressure on the actual wings. In the case, however, of the Gloster high-lift biplane the equivalent wing does not remain in the same position at various speeds. It moves upward with increasing speed of the airplane because of the top wing having more lift. This is shown in Figure 2. Here it will be seen that, as the equivalent wing moves up, so the C.P. moves forward and thus the total movement of the C.P. is less than in the case of the ordinary biplane.

By virtue of this feature, an airplane with these wings has better stability or would give equal stability with a smaller tail.

And now we come to the fourth advantage of the Gloster wing combination, namely, the saving in structure weight. As compared with an ordinary thin wing biplane of greater area, the economy is twofold. First, the saving in fabric covering and interplane bracing, and second, the thick top wing permits of deeper spars, which give equal strength for a lower weight. When compared with a biplane of two thick wings a saving is made on interplane bracing, together with a saving on fuselage and

tail weight due to reduced tail loads.

There is a further advantage in using the thick top wing which, though secondary to the aerodynamical features of the combination, is still of great importance, and that is the ability to house the gasoline tanks inside the top wing and so have more room in the fuselage. At the same time, this tank position provides the means for the ideal gravity feed gasoline system which is so simple and practically foolproof.

In conclusion, the principal advantages of the Gloster high-lift biplane wing combination may be summarized as follows:

1. Increased lift for given wing area or smaller wing area for given lift.
2. Improved performance for given landing speed.
3. Improved stability and control.
4. Reduced structure weight.

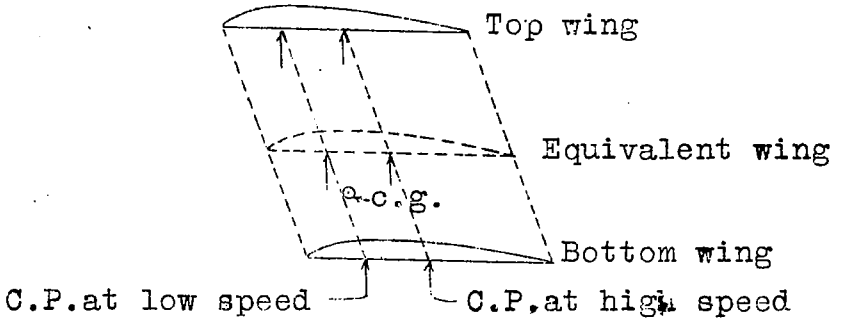

Fig.1 Diagram of ordinary biplane.

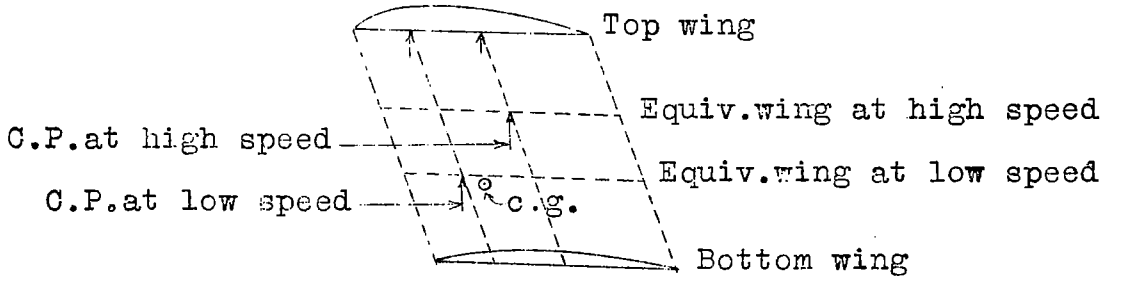

Fig.2 Diagram of equivalent wing for Gloster high lift biplane.